Title: Battery-operated fan and chronic breathlessness: does it help?

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ABSTRACT

Objectives To examine whether use of a hand-held fan ('fan') improves breathlessness and increases physical activity.

Methods A secondary exploratory analysis using pooled data from the fan arms of two feasibility randomised controlled trials in people with chronic breathlessness; i) fan and activity advice *vs* activity advice, ii) activity advice alone or with the addition or the "calming hand", or the fan, or both. Descriptive statistics and regression analysis to explore patient characteristics associated with benefit (e.g. age, sex, diagnosis, general self-efficacy).

Results Forty-one participants were allocated the fan (73 years [IQR 65-76, range 46-88], 59% male, 20 (49%) chronic obstructive pulmonary disease (COPD), three (7%) heart failure, three (7%) cancer). Thirty-five (85%) reported that the fan helped breathing, and 22 (54%) reported increased physical activity.

Breathlessness benefit was more likely in older people, those with COPD and those with a carer. However, due to the small sample size none of these findings were statistically significant. Those with COPD were more likely to use the fan than people with other diagnoses (Odds Ratio 5.94 [95% CI (95%CI) 0.63, 56.21, p=0.120)].

Conclusions These exploratory data support that the fan helps chronic breathlessness in most people and adds new data to indicate that the fan is perceived to increase people's physical activity. There is also a signal of possible particular benefits in people with COPD which is worthy of further study.

Key words airflow; fan; breathlessness; dyspnoea; physical activity

INTRODUCTION

Chronic breathlessness is a common, distressing symptom in people with a range of medical conditions[1] and often persists despite optimal treatment of underlying disease.[2] There is a developing evidence base for non-pharmacological and pharmacological interventions directed at the symptom of breathlessness in its own right,[3, 4] in addition to treatment of the causative medical condition(s).

The use of facial airflow to palliate breathlessness was initially reported in 1987.[5] A simple method of administrating airflow is the battery operated hand-held fan ('fan'). A recent systematic review [6] included a meta-analysis of fan at rest which showed improved subjectively reported breathlessness.[6] An observational feasibility study that showed approximately half of the participants with breathlessness at rest gained a benefit from fan use that persists until further exertion.[7] In a feasibility RCT, more participants still used the fan for breathlessness after two months than those in the control intervention.[8] A mixed-methods feasibility RCT found that patients used the fan as part of a complex intervention, had no adverse effects other than a few were embarrassed to use it in public, and described benefit in the qualitative data.[9] The authors concluded that a further phase III effectiveness trial of the fan alone would give no further value of information.

A secondary pooled analysis of qualitative data from 133 participants found over 80% observed some or substantial benefit from the fan.[10] Other reported benefits included: a shortened recovery time from exertion-induced breathlessness; improved self-management and feeling more in control; and reduced use of beta-agonists and oxygen therapy.[10]

These data support the use of the fan in breathlessness alongside other management strategies, however, no study has reported how patients use the fan in daily life or the fan's impact on physical activity. We therefore conducted an exploratory analysis of patient self-report of fan usage with regard to how it was used, benefit gained for breathlessness and any changes in physical activity.

METHODS

A secondary analysis was conducted using pooled data from the fan arms from two feasibility RCTs in people with chronic breathlessness due to a range of underlying medical conditions (mainly chronic obstructive pulmonary disease [COPD], interstitial lung disease, heart failure, cancer).

Contributing studies

Details of the contributory studies are presented in Online Supplementary Table 1. Detailed methods are reported in the source references and are summarised here. The fan, activity, breathlessness (FAB) study (n=49) was a phase II, multisite, international, parallel arm, non-blinded RCT [9] to test the feasibility of conducting a definitive trial of the fan for the benefit of breathlessness intensity, in addition to simple exercise advice in people with chronic breathlessness. The Calming Hand and fan feasibility (CHAFF) study (n = 40) [6] was a 2x2 factorial, feasibility RCT of activity advice alone or in addition to the Calming Hand, the fan, or both. In both studies, the primary outcomes related to the feasibility of conducting a definitive trial, but data were collected on clinical-demographic characteristics and a range of outcome measures. Both trials used the same bespoke fan use questionnaire, completed by those allocated to the fan arm (Online Appendix 1).

In the FAB and CHAFF studies patients were instructed to hold the fan approximately 15cm from their face and to direct airflow at their nose and/or mouth. Participants were told that the draught of cool air *may* reduce breathlessness, but not given a possible mechanism of action, and they could use it in whichever circumstance they wished (at rest, before, during or after exertion).

Ethics approval was in place prior to recruitment for both studies and was not required for secondary analysis of anonymised data. Principal investigator approval was obtained for data sharing for each study.

Dataset for this study

Data from the fan use questionnaires were pooled to form the analysis set.

Analysis

Descriptive statistics were used to report the patient characteristics and report use and benefit from the fan. The median (IQR) was used for continuous data, and n (%) for categorical data.

Patient characteristics which might be associated with the primary outcome: benefit yes, benefit no, from the questionnaire were explored using logistic regression to calculate the odds ratios (95% CIs). Variables associated with benefit ($p \leq 0.1$) in the univariable analysis or where there was a biological rationale was planned for inclusion in a multi-variable logistic regression model. Variables included: age, sex, diagnosis, general self-efficacy scale (GSES), or the presence of carers. Analyses were conducted using IBM SPSS statistics 24.0.

RESULTS

Forty-one participants were allocated the fan, median age was 73 years (IQR 65-76 years, range 46-88 years), 24 (59%) were male. Of the different primary diagnoses 20 (49%) had COPD, three (7%) heart failure, three (7%) cancer, and 15 (37%) “other”. Four (10%) were using long term oxygen therapy, 14 (34%) had an informal carer and 16 (39%) used a mobility aid. Mean General Self-Efficacy Scale was 31.7 (SD 5) out of a maximum of 40 where higher scores indicate more self-efficacy.

Fan Use

Thirty-five (85%) reported that fan use helped breathlessness, and 22 (54%) felt it enabled them to become more physically active.

All participants reported using the fan during the 28-day study period of whom 31 (76%) used it at least once daily. The median average length of time the fan was used for was 3.3 minutes (IQR 2-5 minutes, range 0 to 10 minutes). The fan was used a median average of five times daily (IQR 2 to 7, range 0 to 20), with most using it in the morning or evening.

People with COPD were more likely to use the fan every day: 61% (n=19) daily use compared to those with other diagnosis (39% (n=12), odds ratio 5.94 (CI 0.63, 56.21), p=0.017.

Predictors of benefit

Findings from the univariable logistic regression analysis are shown in Table 1. Older people, women, those with COPD and those with an informal carer were more likely to gain benefit, however, these did not reach statistical significance and the confidence intervals were very wide. None of the variables reached the criterion of p ≤ 0.1, hence a multivariable regression was not conducted.

Table 1. Univariable regression of patient characteristics and help with breathlessness.

The fan helps breathlessness							
		Yes (35) Mean (SD), median (IQR) or n(%)		No (6) Mean (SD), median (IQR) or n(%)		Odds ratio (95% CI)	p-value
Age		70.7 (9.5) 73 (66-76)		66.5 (9.8) 66 (59-77)		1.05 (0.96, 1.14)	0.324
Sex	Male	20	83%	4	17%	Reference	0.663
	Female	15	88%	2	12%	1.50 (0.24, 9.30)	
Diagnosis	COPD	19	95%	1	5%	5.94 (0.63, 56.21)	0.120
	Other	16	76%	5	24%	Reference	
Carer	Yes	12	86%	2	15%	1.04 (0.17, 6.54)	0.964
	No	23	85%	4	15%	Reference	
GSES		31.2 (4.7) 31 (28-35)		34.5 (6.6.) 36 (27-40)		0.87 (0.72, 1.05)	0.151
SD – Standard Deviation; CI – confidence intervals; IQR – interquartile range; COPD – chronic obstructive pulmonary disease; GSES - general self-efficacy score.							

DISCUSSION

This exploratory analysis found that the fan helped chronic breathlessness in 80% and increased physical activity in over half. Three quarters used the fan daily and those with COPD were more likely to. Older people, those with a carer and those with COPD seemed more likely to gain benefit but these findings did not reach statistical significance.

These data are consistent with previous pooled qualitative data showing benefit in over 80% participants [10]. However, unlike Luckett et al [10] where participants did not refer to increased physical activity directly, these questionnaire data report perceived improved physical activity in a significant proportion. This is plausible given the reported improvement in recovery from exertion; [11] if patients feel they can self-manage recovery from exertion-induced breathlessness (learnt confidence), then they would seem more likely to undertake exertion. Of note, participants were not given information regarding possible mechanism of action, which may have provided additional benefit. [12] Multi-variable analysis of the larger pooled qualitative data study failed to demonstrate any statistically significant predictor of benefit.[10] Our dataset is too small to draw conclusions about predictors of response to the fan although the findings that people with COPD were more likely to use the fan daily might point to benefit being more marked in this patient group. The signal that benefit might be more likely in people with COPD is interesting; however increased use does not necessarily cause benefit. Given the lack of harmful effects other than a few patients who did not like the cool air across the face, then a pragmatic approach of offering the fan to all irrespective of underlying diagnosis is appropriate.

Benefits may feed into self-efficacy of general management of living with chronic breathlessness, although our data did not show any relationship with the GSES; the study participants had a GSES representative of other populations with chronic conditions causing chronic breathlessness.[11]

An exploratory magnetoencephalography study in patients with chronic lung disease identified changes in sensory attention in the presence of airflow.[13] A fan may

mediate benefit by modulation of central perception of breathlessness [10, 14] through trigeminal nerve and vagal afferent stimulation.[14] If patients feel more self-efficacious with fan use, they may be enabled to exercise more aiding re-conditioning over time.

Limitations

Participants were categorised according to primary diagnosis, but almost half, at least of the FAB participants, had multiple diagnoses that could contribute to the breathlessness. As participants were able to use the fan as they wished, if there is a "dose-response" and benefit depends on adherence, then benefit may be underestimated. Conversely, by allowing *ad libitum* use, we were able to identify that those with COPD were more likely to use it daily raising the hypothesis that this may be due to greater benefit.

CONCLUSIONS

Breathlessness is a neglected symptom of many cardio-respiratory conditions, which could benefit from fan use in terms of reduced intensity and increased physical activity. Due to the small size of this study statistical significance was not gained, although trends in certain groups were shown. In the absence of data to identify those most likely to benefit, a fan, with appropriate education should be offered as part of self-management strategies for breathlessness.

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Author contributions

FS and MJ had the concept; FS, MJ, MB-H, VA designed the protocol; SB, DC, JP contributed to original data collection; FS, MB-H, VA conducted the analysis; all authors helped with interpretation; MB-H wrote the first draft; all authors contributed critical revision to successive drafts and agreed the final manuscript.

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Conflicts of Interest

All authors declare no conflicts of interest

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